

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE

(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

MCCALLUM, Graeme, David  
Lloyd Wise  
Tanjong Pagar  
P.O. Box 636  
Singapore 910816  
SINGAPOUR

|  |   |
|--|---|
| Date of mailing (day/month/year)<br>28 March 2001 (28.03.01) | <b>IMPORTANT NOTIFICATION</b>   |
| Applicant's or agent's file reference<br>FP1183              |   |
| International application No.<br>PCT/SG99/00074              | International filing date (day/month/year)<br>09 July 1999 (09.07.99) |

1. The following indications appeared on record concerning:

☒ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address

COTTERELL, Brian  
55 Lorong Sarhad  
Singapore 119166  
Singapore

State of Nationality

GB

State of Residence

SG

Telephone No.

Facsimile No.

Teleprinter No.

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☒ the residence

Name and Address

COTTERELL, Brian  
146 Condamine St.  
Balgowlah, NSW 2093  
Australia

State of Nationality

GB

State of Residence

AU

Telephone No.

Facsimile No.

Teleprinter No.

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office ☒ the designated Offices concerned  
☐ the International Searching Authority ☐ the elected Offices concerned  
☐ the International Preliminary Examining Authority ☐ other:

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

I. Britel

Telephone No.: (41-22) 338.83.38

PCT

**NOTIFICATION OF THE RECORDING  
OF A CHANGE**

(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

MCCALLUM, Graeme, David  
Lloyd Wise  
Tanjong Pagar  
P.O. Box 636  
Singapore 910816  
SINGAPOUR

|  |   |
|--|---|
| Date of mailing (day/month/year)<br>28 March 2001 (28.03.01) | <b>IMPORTANT NOTIFICATION</b>   |
| Applicant's or agent's file reference<br>FP1183              |   |
| International application No.<br>PCT/SG99/00074              | International filing date (day/month/year)<br>09 July 1999 (09.07.99) |

1. The following indications appeared on record concerning:

☒ the applicant ☐ the inventor ☐ the agent ☐ the common representative

Name and Address

INSTITUTE OF MATERIALS RESEARCH &  
ENGINEERING  
Blk S7 Level 3 Kent Ridge Crescent  
Singapore 119260  
Singapore

State of Nationality

SG

State of Residence

SG

Telephone No.

Facsimile No.

Teleprinter No.

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address

INSTITUTE OF MATERIALS RESEARCH &  
ENGINEERING  
3 Research Lind  
Singapore 117602  
Singapore

State of Nationality

SG

State of Residence

SG

Telephone No.

Facsimile No.

Teleprinter No.

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office ☒ the designated Offices concerned  
☐ the International Searching Authority ☐ the elected Offices concerned  
☐ the International Preliminary Examining Authority ☐ other:

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

I. Britel

Telephone No.: (41-22) 338.83.38

## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

|  |   |   |
|--|---|---|
| Applicant's or agent's file reference<br><b>FP1183</b>                       | FOR FURTHER ACTION <small>see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.</small> |   |
| International application No.<br><b>PCT/SG 99/00074</b>                      | International filing date (day/month/year)<br><b>09 July 1999 (09.07.99)</b>  | (Earliest) Priority Date (day/month/year)<br><b>-</b> |
| Applicant<br><b>Institute of Materials Research &amp; Engineering et al.</b> |   |   |

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

## 1. Basis of the report

a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☐ Unity of invention is lacking (See Box II).

4. With regard to the title,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.: 2

☒ as suggested by the applicant.

☐ None of the figures.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SG 99/00074

## A. CLASSIFICATION OF SUBJECT MATTER

IPC<sup>7</sup>: H01L 21/027; 21/308; 21/311; 21/321

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC<sup>7</sup>: H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, PAJ, EPODOC

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category*   | Citation of document, with indication, where appropriate, of the relevant passages            | Relevant to claim No.   |
|-------------|---|-------------------------|
| X<br>Y<br>A | US5669303 A (MARACAS et al.) 23 September 1997 (23.09.97)<br>abstract, fig.1,2,3,11; claim 1. | 1<br>2,3<br>4-53; 55-61 |
| Y<br>A      | GB 2332985 A (PIONEER) 07 July 1999 (07.07.99), abstract.                                     | 2,3<br>4-52; 55-61      |
| X<br>X      | US 5259926 A (KUWABARA) 09 November 1993 (09.11.93)<br>abstract, fig. 1-4, claims 1, 14-26.   | 1,54                    |
| A           | WO 97/06012 A1 (IBMC) 20 February 1997 (20.02.97) abstract,<br>fig. 1,2,3.                    | 1, 54                   |
| ----        |   |                         |

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

## \* Special categories of cited documents:

„A“ document defining the general state of the art which is not considered to be of particular relevance

„E“ earlier application or patent but published on or after the international filing date

„L“ document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

„O“ document referring to an oral disclosure, use, exhibition or other means

„P“ document published prior to the international filing date but later than the priority date claimed

„T“ later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

„X“ document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

„Y“ document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

„&amp;“ document member of the same patent family

Date of the actual completion of the international search

09 May 2000 (09.05.00)

Date of mailing of the international search report

20 June 2000 (20.06.00)

Name and mailing address of the ISA/AT

Austrian Patent Office

Kohlmarkt 8-10; A-1014 Vienna

Facsimile No. 1/53424/200

Authorized officer

Mayer

Telephone No. 1/53424/452

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/SG 99/00074**

| Patent document cited<br>in search report |    |         | Publication<br>date | Patent family<br>member(s) |    |          | Publication<br>date |
|---|----|---------|---------------------|----------------------------|----|----------|---------------------|
| US  | A  | 5669303 | 23-09-1997          | EP                         | A1 | 794016   | 10-09-1997          |
|   |    |         |                     | JP                         | A2 | 9240125  | 16-09-1997          |
| GB  | A1 | 2332985 | 07-07-1999          | GB                         | A0 | 9828870  | 17-02-1999          |
|   |    |         |                     | JP                         | A2 | 11195491 | 21-07-1999          |
| US  | A  | 5259926 | 09-11-1993          | JP                         | A2 | 5080530  | 02-04-1993          |
| WO  | A1 | 9706012 | 20-02-1997          | EP                         | A1 | 784542   | 23-07-1997          |
|   |    |         |                     | JP                         | T2 | 9511710  | 25-11-1997          |
|   |    |         |                     | US                         | A  | 5817242  | 06-10-1998          |

# Literaturblatt zum Stand der Technik

---

**Fall-Nummer:** 1999P8116

**Titel:** Mechanical Patterning of a device Layer

**Mandanten-Referenz:** Pz02

**in der Beschreibungseinleitung genannter SdT**

Burroughes et al., Nature 347 (1990) 539

US4,720,432

**internat. Recherchenbericht/Prüfungsverfahren**

WO9706012

US5,259,926

GB2332985

US5,669,303

PCT

## REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference  
(if desired) (12 characters maximum) FP1183

## Box No. I TITLE OF INVENTION

Mechanical Patterning Of A Device Layer

## Box No. II APPLICANT

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

Institute of Materials Research &  
Engineering  
Blk S7 Level 3 Kent Ridge Crescent  
Singapore 119260

☐ This person is also inventor.

Telephone No.

Facsimile No.

Telex No.

State (that is, country) of nationality:  
SingaporeState (that is, country) of residence:  
Singapore

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

## Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

OSRAM Opto Semiconductors GmbH & Co. OHG  
Wernerwerkstr. 2  
D-93049 Regensburg,  
Germany

This person is:

☒ applicant only☐ applicant and inventor☐ inventor only (if this check-box is marked, do not fill in below)State (that is, country) of nationality:  
GermanyState (that is, country) of residence:  
Germany

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

## Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:

☒ agent☐ common representative

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

MCCALLUM, GRAEME DAVID  
LLOYD WISE  
TANJONG PAGAR P O BOX 636  
SINGAPORE 910816

Telephone No.

227 8986

Facsimile No.

227 3898

Telex No.

☐ Address for correspondence: Mark this check-box where no agent or common representative has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

See Notes to the request form

Sheet No. 2

## Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

GUENTHER Ewald Karl Michael  
991 Bukit Timah Road, #03-11 Maplewoods  
Singapore 589630

This person is:

☐ applicant only☒ applicant and inventor☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:  
Germany

State (that is, country) of residence:  
Singapore

This person is applicant  
for the purposes of:

☐ all designated States☐ all designated States except the United States of America☒ the United States of America only☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

CHEN Zhong  
Blk 233 Bukit Batok East Avenue 5  
#11-39  
Singapore 650233

This person is:

☐ applicant only☒ applicant and inventor☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:  
China

State (that is, country) of residence:  
Singapore

This person is applicant  
for the purposes of:

☐ all designated States☐ all designated States except the United States of America☒ the United States of America only☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

COTTERELL Brian  
55 Lorong Sarhad  
Singapore 119166

This person is:

☐ applicant only☒ applicant and inventor☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:  
British

State (that is, country) of residence:  
Singapore

This person is applicant  
for the purposes of:

☐ all designated States☐ all designated States except the United States of America☒ the United States of America only☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

This person is:

☐ applicant only☐ applicant and inventor☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

State (that is, country) of residence:

This person is applicant  
for the purposes of:

☐ all designated States☐ all designated States except the United States of America☐ the United States of America only☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

See Notes to the request form



## Box No. DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked):

## Regional Patent

- ☒ AP ARIPO Patent: GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SZ Swaziland, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ EA Eurasian Patent: AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ EP European Patent: AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ OA OAPI Patent: BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT (If other kind of protection or treatment desired, specify on dotted line)

## National Patent (If other kind of protection or treatment desired, specify on dotted line):

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> AL Albania                               | <input checked="" type="checkbox"/> LS Lesotho                                   |
| <input checked="" type="checkbox"/> AM Armenia                               | <input checked="" type="checkbox"/> LT Lithuania                                 |
| <input checked="" type="checkbox"/> AT Austria                               | <input checked="" type="checkbox"/> LU Luxembourg                                |
| <input checked="" type="checkbox"/> AU Australia                             | <input checked="" type="checkbox"/> LV Latvia                                    |
| <input checked="" type="checkbox"/> AZ Azerbaijan                            | <input checked="" type="checkbox"/> MD Republic of Moldova                       |
| <input checked="" type="checkbox"/> BA Bosnia and Herzegovina                | <input checked="" type="checkbox"/> MG Madagascar                                |
| <input checked="" type="checkbox"/> BB Barbados                              | <input checked="" type="checkbox"/> MK The former Yugoslav Republic of Macedonia |
| <input checked="" type="checkbox"/> BG Bulgaria                              | <input checked="" type="checkbox"/> MN Mongolia                                  |
| <input checked="" type="checkbox"/> BR Brazil                                | <input checked="" type="checkbox"/> MW Malawi                                    |
| <input checked="" type="checkbox"/> BY Belarus                               | <input checked="" type="checkbox"/> MX Mexico                                    |
| <input checked="" type="checkbox"/> CA Canada                                | <input checked="" type="checkbox"/> NO Norway                                    |
| <input checked="" type="checkbox"/> CH and LI Switzerland and Liechtenstein  | <input checked="" type="checkbox"/> NZ New Zealand                               |
| <input checked="" type="checkbox"/> CN China                                 | <input checked="" type="checkbox"/> PL Poland                                    |
| <input checked="" type="checkbox"/> CU Cuba                                  | <input checked="" type="checkbox"/> PT Portugal                                  |
| <input checked="" type="checkbox"/> CZ Czech Republic                        | <input checked="" type="checkbox"/> RO Romania                                   |
| <input checked="" type="checkbox"/> DE Germany                               | <input checked="" type="checkbox"/> RU Russian Federation                        |
| <input checked="" type="checkbox"/> DK Denmark                               | <input checked="" type="checkbox"/> SD Sudan                                     |
| <input checked="" type="checkbox"/> EE Estonia                               | <input checked="" type="checkbox"/> SE Sweden                                    |
| <input checked="" type="checkbox"/> ES Spain                                 | <input checked="" type="checkbox"/> SG Singapore                                 |
| <input checked="" type="checkbox"/> FI Finland                               | <input checked="" type="checkbox"/> SI Slovenia                                  |
| <input checked="" type="checkbox"/> GB United Kingdom                        | <input checked="" type="checkbox"/> SK Slovakia                                  |
| <input checked="" type="checkbox"/> GE Georgia                               | <input checked="" type="checkbox"/> SL Sierra Leone                              |
| <input checked="" type="checkbox"/> GH Ghana                                 | <input checked="" type="checkbox"/> TJ Tajikistan                                |
| <input checked="" type="checkbox"/> GM Gambia                                | <input checked="" type="checkbox"/> TM Turkmenistan                              |
| <input checked="" type="checkbox"/> GW Guinea-Bissau                         | <input checked="" type="checkbox"/> TR Turkey                                    |
| <input checked="" type="checkbox"/> HR Croatia                               | <input checked="" type="checkbox"/> TT Trinidad and Tobago                       |
| <input checked="" type="checkbox"/> HU Hungary                               | <input checked="" type="checkbox"/> UA Ukraine                                   |
| <input checked="" type="checkbox"/> ID Indonesia                             | <input checked="" type="checkbox"/> UG Uganda                                    |
| <input checked="" type="checkbox"/> IL Israel                                | <input checked="" type="checkbox"/> US United States of America                  |
| <input checked="" type="checkbox"/> IS Iceland                               |  |
| <input checked="" type="checkbox"/> JP Japan                                 |  |
| <input checked="" type="checkbox"/> KE Kenya                                 | <input checked="" type="checkbox"/> UZ Uzbekistan                                |
| <input checked="" type="checkbox"/> KG Kyrgyzstan                            | <input checked="" type="checkbox"/> VN Viet Nam                                  |
| <input checked="" type="checkbox"/> KP Democratic People's Republic of Korea | <input checked="" type="checkbox"/> YU Yugoslavia                                |
|  | <input checked="" type="checkbox"/> ZW Zimbabwe                                  |
| <input checked="" type="checkbox"/> KR Republic of Korea                     |  |
| <input checked="" type="checkbox"/> KZ Kazakhstan                            |  |
| <input checked="" type="checkbox"/> LC Saint Lucia                           |  |
| <input checked="" type="checkbox"/> LK Sri Lanka                             |  |
| <input checked="" type="checkbox"/> LR Liberia                               |  |
| <input checked="" type="checkbox"/> ZA South Africa                          |  |

Check-boxes reserved for designating States (for the purposes of a national patent) which have become party to the PCT after issuance of this sheet:

- ☒ IN India
- ☒ UAE United Arab Emirates

**Precautionary Designation Statement:** In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)

| Box No. <b>PRIORITY CLAIM</b>                       |                               | Further priority claims are indicated in the Supplemental Box. |                                       |   |
|---|-------------------------------|--|---------------------------------------|---|
| Filing date of earlier application (day/month/year) | Number of earlier application | Where earlier application is:                                  |                                       |   |
|   |                               | national application: country                                  | regional application: regional Office | international application: receiving Office |
| item (1)  |                               |  |                                       |   |
| item (2)  |                               |  |                                       |   |
| item (3)  |                               |  |                                       |   |

☐ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office) identified above as item(s):

\* Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.

### Box No. VII INTERNATIONAL SEARCHING AUTHORITY

|   |  |
|---|--|
| Choice of International Searching Authority (ISA) (If two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used): | Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority): |
| ISA / AT  | Date (day/month/year)      Number      Country (or regional Office)  |

### Box No. VIII CHECK LIST: LANGUAGE OF FILING

|   |  |
|---|--|
| This international application contains the following number of sheets: | This international application is accompanied by the item(s) marked below:                                       |
| request : 4   | 1. <input checked="" type="checkbox"/> fee calculation sheet   |
| description (excluding sequence listing part) : 1 1                     | 2. <input type="checkbox"/> separate signed power of attorney  |
| claims : 1 2  | 3. <input type="checkbox"/> copy of general power of attorney, reference number, if any:                         |
| abstract : 1  | 4. <input type="checkbox"/> statement explaining lack of signature   |
| drawings : 5  | 5. <input type="checkbox"/> priority document(s) identified in Box No. VI as item(s):                            |
| sequence listing part of description :                                  | 6. <input type="checkbox"/> translation of international application into (language):                            |
| Total number of sheets : 3 3  | 7. <input type="checkbox"/> separate indications concerning deposited microorganism or other biological material |
|   | 8. <input type="checkbox"/> nucleotide and/or amino acid sequence listing in computer readable form              |
|   | 9. <input checked="" type="checkbox"/> other (specify): P F 4 8  |
| Figure of the drawings which should accompany the abstract: 2           | Language of filing of the international application: English   |

### Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

-----  
**MCCALLUM, GRAEME DAVID**  
**AGENTS FOR THE APPLICANTS**

|   |  |  |
|---|--|--|
| For receiving Office use only   |  | 2. Drawings:<br><br><input type="checkbox"/> received:<br><br><input type="checkbox"/> not received: |
| 1. Date of actual receipt of the purported international application:   |  |  |
| 3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application: |  |  |
| 4. Date of timely receipt of the required corrections under PCT Article 11(2):  |  |  |
| 5. International Searching Authority (if two or more are competent): ISA /  | 6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid. |  |

|   |                               |
|---|-------------------------------|
| For International Bureau use only                               |                               |
| Date of receipt of the record copy by the International Bureau: | See Notes to the request form |

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
18 January 2001 (18.01.2001)

PCT

(10) International Publication Number  
**WO 01/04938 A1**

(51) International Patent Classification<sup>7</sup>: **H01L 21/027**,  
21/308, 21/311, 21/321

#11-39, Singapore 650233 (SG). **COTTERELL, Brian**  
[GB/SG]; 55 Lorong Sarhad, Singapore 119166 (SG).

(21) International Application Number: **PCT/SG99/00074**

(74) Agent: **MCCALLUM, Graeme, David**; Lloyd Wise, Tan-  
jong Pagar, P.O. Box 636, Singapore 910816 (SG).

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(71) Applicants (for all designated States except US): **INSTITUTE OF MATERIALS RESEARCH & ENGINEERING** [SG/SG]; Blk S7 Level 3 Kent Ridge Crescent, Singapore 119260 (SG). **OSRAM OPTO SEMICONDUCTORS GMBH & CO. OHG** [DE/DE]; Wernerwerkstrasse 2, D-93049 Regensburg (DE).

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(72) Inventors; and

(75) Inventors/Applicants (for US only): **GUENTHER, Ewald, Karl, Michael** [DE/SG]; 991 Bukit Timah Road, #03-11 Maplewoods, Singapore 589630 (SG). **CHEN, Zhong** [CN/SG]; Blk 233 Bukit Batok East Avenue 5,

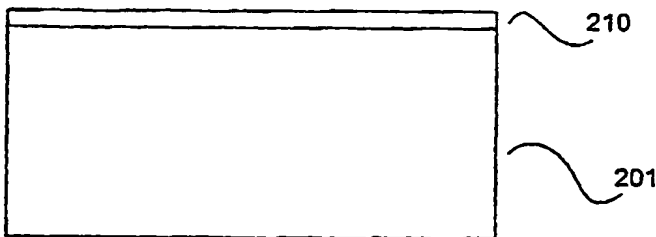
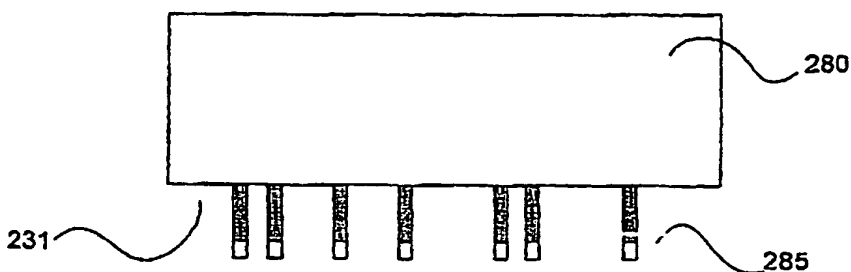
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(54) Title: MECHANICAL PATTERNING OF A DEVICE LAYER



(57) Abstract: A method of fabricating a device comprising mechanically patterning a device layer using a stamp containing the desired pattern. The device layer is formed on a plastic or polymeric substrate. The stamp is pressed against the substrate under a load which patterns the device layer without cracking it in the non-patterned areas.

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**MECHANICAL PATTERNING OF A DEVICE LAYER****Field of the Invention**

The present invention relates to the fabrication of  
5 devices. More particularly, the invention relates to  
patterning of a device layer on a substrate.

**Background of the Invention**

In device fabrication, one or more device layers  
10 are formed on a substrate. The layers are sequentially  
deposited and patterned to create features on the  
surface of the substrate. The layers can be patterned  
individually and/or as a combination of layers to form  
the desired features. The features serve as components  
15 that perform the desired functions, creating the device.

One type of device which is of particular interest  
is a light emitting diode (LED). Typically, an LED cell  
or pixel comprises one or more functional layers  
sandwiched between two electrodes to form a functional  
20 stack. Charge carriers are injected from both  
electrodes. These charge carriers recombine in the  
functional layer or layers, causing visible radiation to  
emit. Recently, significant advances have been made  
utilizing organic functional layers to form organic LEDs

(OLEDs). Such devices are fabricated on rigid glass substrates having a thickness of about 0.3-1.1 mm.

Typically, OLED devices comprises a plurality of OLED pixels arranged to form a display, such as a flat panel display (FPD). A pixelated OLED device includes, for example, a plurality of first electrode strips formed on the substrate. The strips are arranged in a first direction. One or more organic layers are formed on the first electrodes strips. A plurality of second electrode strips is formed over the organic layers in a second direction. Typically, the first and second electrode strips are orthogonal to each other. The intersections of the first and second electrode strips form LED pixels.

The first electrode strips are created on the substrate by patterning an electrode layer. Conventionally, the electrode layer is patterned by photolithographic and etch processes. For example, a photosensitive resist layer is deposited on the electrode. The resist layer is exposed with radiation having the desired pattern defined by a mask. After development, unwanted resist is removed to expose portions of the electrode beneath. The exposed portions are removed by a wet etch, leaving the desired pattern

on the electrode layer. Thus, conventional techniques for patterning the electrode require numerous steps, increasing raw process time and manufacturing cost.

As evidenced by the above discussion, it is  
5 desirable to provide a simplified process of patterning a device layer.

### Summary of the Invention

The invention relates to patterning a device layer  
10 on a substrate during device fabrication. In accordance with the invention, the patterning of the device layer is achieved using a stamp with a pattern thereon. The pattern is formed by protrusions having a height greater than the thickness of the device layer to pattern the  
15 device layer. The stamp is pressed against the surface of the substrate under a load which patterns the device layer. The load is selected to precisely control cracking the edges of the patterned areas but without cracking the non-patterned areas.

20

### Brief Description of the Drawings

Fig. 1 shows an organic pixel LED;

Figs. 2-4 show a process for patterning a device layer in accordance with one embodiment of the invention; and

Fig. 5 shows an alternative process for patterning  
5 a device layer.

### **Preferred Embodiments of the Invention**

The invention relates generally to the fabrication of devices. In particular, the invention describes a  
10 process for patterning a device layer on a substrate, particularly a device layer formed on a ductile or flexible substrate. Various types of devices can be formed by the present invention. For example, electrical, mechanical, or electromechanical devices can  
15 be formed. Also, the invention can be useful in fabricating a microelectromechanical system (MEMS). In one embodiment, a process for forming a pixelated organic LED device is provided.

Fig. 1 shows a cross-section of an OLED pixel. As  
20 shown, a substrate 101 is provided. The substrate provides support for the LED pixel. A functional stack 105 comprising of one or more organic functional layers 120 formed between conductive layers 110 and 150 is formed on the substrate, creating the LED pixel. The



conductive layer 110 serves as an anode and the  
conductive layer 150 serves as a cathode.

A plurality of LED pixels can be arranged on the  
substrate to form an FPD. The FPD is used in various  
5 consumer electronic products, including cellular phones,  
cellular smart phones, personal organizers, pagers,  
advertising panel, touch screen displays,  
teleconferencing equipment, multimedia equipment,  
virtual reality products, and display kiosks.

10 Figs. 2-5 show a process for patterning a device  
layer on a substrate in the fabrication of a device. In  
one embodiment, the device fabricated comprises a  
pixelated OLED device. Forming other types of devices  
such as electrical and/or mechanical devices, including  
15 sensor arrays, is also useful.

Referring to Fig. 2, a substrate 201 is provided on  
which the active components of the device are formed.  
The substrate comprises a plastic or a polymeric  
material. In one embodiment, the substrate comprises a  
20 flexible substrate, such as poly(ethylene terephthalate)  
(PET) or polyester for forming flexible devices. The  
substrate can comprise a transparent substrate to serve  
as, for example, a display surface for an OLED display.  
The use of a flexible transparent substrate for forming

a flexible display is also useful. Various types of plastic substrates, such as PET, poly(butylene terephthalate) (PBT), poly(ethylene naphthalate) (PEN), Polycarbonate (PC), polyimides (PI), polysulfones (PSO),  
5 and poly(p-phenylene ether sulfone) (PES) are useful. Other substrates comprising polyethylene (PE), polypropylene (PP), poly(vinyl chloride) (PVC), polystyrene (PS) and poly(methyl methacrylate) (PMMA), can also be used.

10 In one embodiment, the substrate should be thin to result in a thin device while providing sufficient mechanical integrity during the fabrication process to support the active components. Preferably, the substrate should be as thin as possible while providing  
15 sufficient mechanical integrity during the fabrication process. The substrate thickness is, for example, about 20 - 200  $\mu\text{m}$ . Thicker substrates are also useful. For example, thicker substrate, can be used where device thickness or flexibility is not an issue.

20 A device layer 210 is formed on the substrate. The device layer comprises, for example, a conductive layer. Other types of device layers, such as dielectrics or semiconductors, are also useful. In one embodiment the device layer comprises a transparent

conductive layer that serves as an electrode for an LED device. The transparent conductive layer comprises an indium-tin-oxide (ITO). ITO is useful in forming the transparent anode of the LED device. Other transparent  
5 conductive layers, including zinc-oxide or indium-zinc-oxide are also useful. Various techniques, such as sputtering, physical vapor deposition (PVD), chemical vapor deposition (CVD) or plasma enhanced CVD (PECVD) can be employed to form the device layer. The device  
10 layer is deposited on the substrate to a thickness of about, for example, 100 nm. The thickness, of course, can vary depending on design requirements.

A stamp 280 comprising a desired pattern on a surface 231 is provided. The pattern is define by  
15 protrusions 285 on surface 231. The stamp is made of a hard material such as steel, silicon, or ceramic. Other materials that are sufficiently hard can also be used to form the stamp.

In one embodiment, the pattern is deeper than the  
20 thickness of the device layer. This ensures proper patterning of the device layer. However, the height of the protrusions should be less than that which would compromise the support function of the substrate. In one embodiment, the height of the protrusions is at

least about 2 - 10 times the thickness of the device layer, preferably 5 - 10 times the thickness of the device layer. For example, the height of the protrusions is about 0.5 - 1  $\mu\text{m}$  for a 100 nm thick device layer. The height of the protrusions can be optimized according to the mechanical properties and thickness of the substrate.

Referring to Fig. 3, a load is applied on the stamp 280, forcing the stamp against the substrate 201. This causes the pattern on the stamp to be transferred to the substrate. The load applied on the stamp is sufficient to prevent the device layer 210 from cracking in the active or non-patterned areas as it is patterned. In one embodiment, the net pressure of the load is about 200 - 400 MPa for a typical polymer substrate. In general, the required net pressure should exceed about 1.1 times the yield strength of the substrate material.

Referring to Fig. 4, the stamp is lifted from the substrate. As shown, the pattern on the stamp is transferred onto the device layer. In one embodiment, the device layer is patterned to form electrode strips on the substrate. Conventional processing continues to form the device.

In one embodiment, the process continues to fabricate OLED pixels of an OLED device. Fabrication of OLED pixels is described in, for example, United States Patent 4,720,432 and Burroughes et. al, Nature 347 (1990) 539, which are herein incorporated by reference for all purposes. This includes, for example, depositing one or more organic functional layers, such as conjugated polymer or Alq<sub>3</sub>, on the electrode. Other types of organic layers can also be useful. Preferably, a plurality of functional layers is formed on the electrode. Second electrode strips comprising metal such as aluminum or other conductive material are formed over the functional layer. The second electrode strips are typically orthogonal to the bottom electrode strips. Providing second electrode strips that are diagonal to the bottom electrode strips is also useful. The intersections of the top and bottom electrode strips form OLED pixels. Various techniques can be used to form the electrode strips. For example, the second electrode strips can be formed by selective deposition techniques. Alternatively, the electrode strip can be formed by selectively patterning a top electrode layer to form the strips.

In an alternative embodiment, the pattern on the stamp can be formed to include a plurality of devices for parallel processing, thereby decreasing process time per device. The stamp pattern can be formed by a  
5 variety of techniques. Such techniques include, for example, grinding or photolithographic and etch processes.

Fig. 5 shows another embodiment of the invention. As shown, a stamp comprising a drum 580 with the desired  
10 pattern 585 thereon is provided. The drum stamp is used in reel-to-reel processing. A long flexible substrate 501 with a device layer 510 formed thereon is provided. The substrate is translated through the drum while it is pressed under rotation, patterning the device layer. As  
15 shown, the substrate is translated in a direction from right to left and the drum stamp is rotated in the clockwise direction. Reversing the direction that the substrate is translated is also useful. Reel-to-reel processing enables parallel processing of devices.

20 While the invention has been particularly shown and described with reference to various embodiments, it will be recognized by those skilled in the art that modifications and changes may be made to the present invention without departing from the spirit and scope

thereof. The scope of the invention should therefore be determined not with reference to the above description but with reference to the appended claims along with their full scope of equivalents.

What is claimed is:

1. In the fabrication of a device, a method of patterning a device layer comprising:  
providing a substrate comprising the device layer  
5 on its surface; and  
patterning the device layer by pressing a stamp comprising a pattern against the substrate.
2. The method of claim 1 wherein the device comprises  
10 an organic LED device.
3. The method of claim 2 wherein the substrate comprises a polymeric substrate.
- 15 4. The method of claim 3 wherein the substrate comprises a flexible or ductile substrate.
5. The method of claim 4 wherein the substrate comprises a transparent substrate.
- 20 6. The method of claim 5 wherein the device layer comprises a transparent conductive layer.



7. The method of claim 6 wherein the transparent conductive layer comprises a conductive oxide.

8. The method of claim wherein 7 conductive oxide  
5 comprises indium-tin-oxide.

9. The method of claim 8 wherein the pattern is produced by protrusions on a surface of the stamp.

10 10. The method of claim 9 wherein patterning the device layer forms lower electrodes on the substrate.

11. The method of claim 10 wherein the protrusions comprise a height greater than a thickness of the device  
15 layer.

12. The method of claim 11 wherein the height of the protrusions is at least about 2 - 10 times greater than the thickness of the device layer.

20

13. The method of claim 12 wherein the stamp is pressed against the substrate surface under a load without causing the device layer to crack in non-patterned areas.

14. The method of claim 13 wherein the load comprises a net pressure of greater than about 1.10 times a yield strength of the substrate.

5

15. The method of claim 14 further comprises processing to form OLED pixels.

16. The method of claim 15 wherein the processing to  
10 form OLED pixels comprises:

forming at least one organic functional layer on lower electrodes; and

forming upper electrodes on the organic functional layer, wherein OLED pixels are formed where upper and  
15 lower electrodes sandwich the organic functional layer.

17. The method of claim 3 wherein the substrate comprises a transparent substrate.

20 18. The method of claim 17 wherein the device layer comprises a transparent conductive layer.

19. The method of claim 18 wherein the pattern is produced by protrusions on a surface of the stamp.

20. The method of claim 19 wherein patterning the device layer forms lower electrodes on the substrate.

5 21. The method of claim 20 wherein the protrusions comprise a height greater than a thickness of the device layer.

22. The method of claim 21 wherein the stamp is pressed  
10 against the substrate surface under a load without causing the device layer to crack in non-patterned areas.

23. The method of claim 22 further comprises processing  
15 to form OLED pixels.

24. The method of claim 23 wherein the processing to form OLED pixels comprises:

forming at least one organic functional layer on  
20 lower electrodes; and

forming upper electrodes on the organic functional layer, wherein OLED pixels are formed where upper and lower electrodes sandwich the organic functional layer.

25. The method of claim 3 wherein the device layer comprises a conductive layer.

26. The method of claim 25 wherein the pattern is  
5 produced by protrusions on a surface of the stamp.

27. The method of claim 26 wherein patterning the device layer forms lower electrodes on the substrate.

10 28. The method of claim 27 wherein the protrusions comprise a height greater than a thickness of the device layer.

29. The method of claim 28 wherein the stamp is pressed  
15 against the substrate surface under a load without causing the device layer to crack in non-patterned areas.

30. The method of claim 29 further comprises processing  
20 to form OLED pixels.

31. The method of claim 30 wherein the processing to form OLED pixels comprises:

forming at least one organic functional layer on lower electrodes; and

forming upper electrodes on the organic functional layer, wherein OLED pixels are formed where upper and  
5 lower electrodes sandwich the organic functional layer.

32. The method of claim 2 wherein the substrate comprises a material selected from the group consisting of polyester, poly(ethylene terephthalate),  
10 poly(butylene terephthalate), poly(enthylene naphthalate), polyethylenesterephthalate, polycarbonate, polyimides, polysulfones, poly(*p*-phenylene ether sulfone), polyethylene, polypropylene, poly(vinyl chloride), polystyrene, and poly(methyl  
15 methyleacrylate).

33. The method of claim 32 wherein the device layer comprises a conductive layer.

20

34. The method of claim 33 wherein the pattern is produced by protrusions on a surface of the stamp, the pattern is used to form lower electrodes on the substrate.

25

35. The method of claim 34 wherein the protrusions comprise a height greater than a thickness of the device layer to pattern the device layer.

5 36. The method of claim 35 wherein the stamp is pressed against the substrate surface under a load without causing the device layer to crack in non-patterned areas.

10 37. The method of claim 36 further comprises processing to form OLED pixels comprising:

forming at least one organic functional layer on lower electrodes; and

forming upper electrodes on the organic functional  
15 layer, wherein OLED pixels are formed where upper and lower electrodes sandwich the organic functional layer.

38. The method of claim 1 wherein the substrate comprises a polymeric substrate.

20

39. The method of claim 38 wherein the pattern is produced by protrusions on a surface of the stamp.

40. The method of claim 39 wherein the protrusions comprise a height greater than a thickness of the device layer.

5 41. The method of claim 40 wherein the height of the protrusions is at least about 5-10 times greater than the thickness of the device layer.

42. The method of claim 41 wherein the stamp is pressed  
10 against the substrate surface under a load without causing the device layer to crack in non-patterned areas.

43. The method of claim 42 wherein the load comprises a  
15 net pressure of greater than about 1.1 times a yield strength of the substrate.

44. The method of claim 43 further comprises processing to form the device.

20

45. The method of claim 44 wherein the device comprises a device selected from the group consisting of an electrical device, a mechanical device, a

electromechanical device, and a microelectromechanical system.

46. The method of claim 40 wherein the stamp is pressed  
5 against the substrate surface under a load without causing the device layer to crack in non-patterned areas.

47. The method of claim 46 further comprises processing  
10 to form the device.

48. The method of claim 47 wherein the device comprises a device selected from the group consisting of an electrical device, a mechanical device, a  
15 electromechanical device, and a microelectromechanical system.

49. The method of claim 1 wherein the substrate comprises a material selected from the group consisting  
20 of polyester, poly(ethylene terephthalate), poly(butylene terephthalate), poly(enthylene naphthalate), polyethylenesterephthalate, polycarbonate, polyimides, polysulfones, poly(p-phenylene ether sulfone), polyethylene, polypropylene, poly(vinyl



chloride), polystyrene, and poly(methyl methyleacrylate).

5 50. The method of claim 49 wherein the pattern is produced by protrusions on a surface of the stamp.

51. The method of claim 50 wherein the protrusions comprise a height greater than a thickness of the device  
10 layer to pattern the device layer.

52. The method of claim 51 wherein the stamp is pressed against the substrate surface under a load without causing the device layer to crack in non-patterned  
15 areas.

53. The method of claim 52 further comprises processing to form the device.

20 54. A method of patterning comprising:

rotating a stamp comprising a drum with a pattern;  
and

translating a substrate with a device layer thereon as the stamp is rotated to pattern the device.

55. The method of claim 1 wherein the substrate comprises a polymeric substrate.

56. The method of claim 55 wherein the pattern is  
5 produced by protrusions on a surface of the stamp.

57. The method of claim 56 wherein the protrusions comprise a height greater than a thickness of the device layer to pattern the device layer.

10

58. The method of claim 57 wherein the stamp is pressed against the substrate surface under a load without causing the device layer to crack in non-patterned areas.

15

59. The method of claim 58 further comprises processing to form the device.

60. The method of claim 59 wherein the device comprises  
20 a device selected from the group consisting of an electrical device, a mechanical device, a electromechanical device, and a microelectromechanical system.

61. The method of claim 59 wherein the device comprises an OLED device.

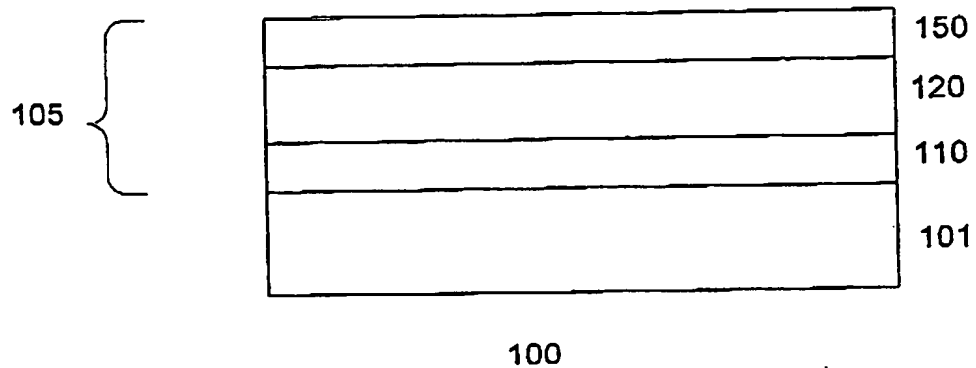


Fig. 1

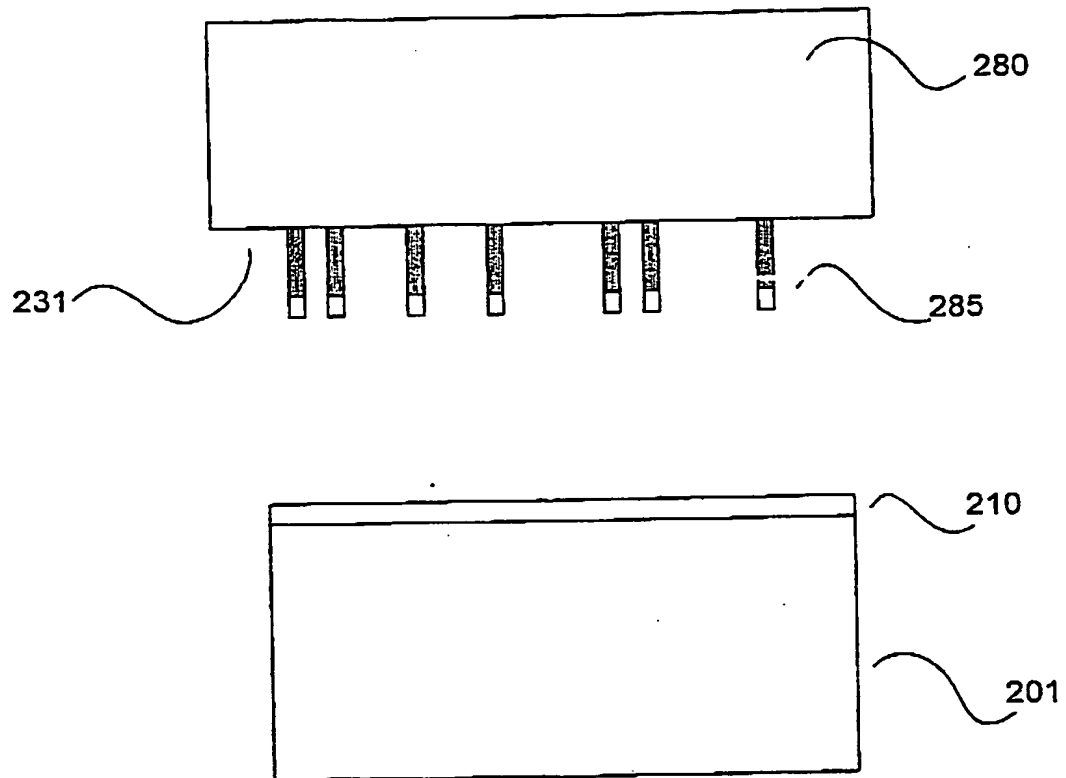
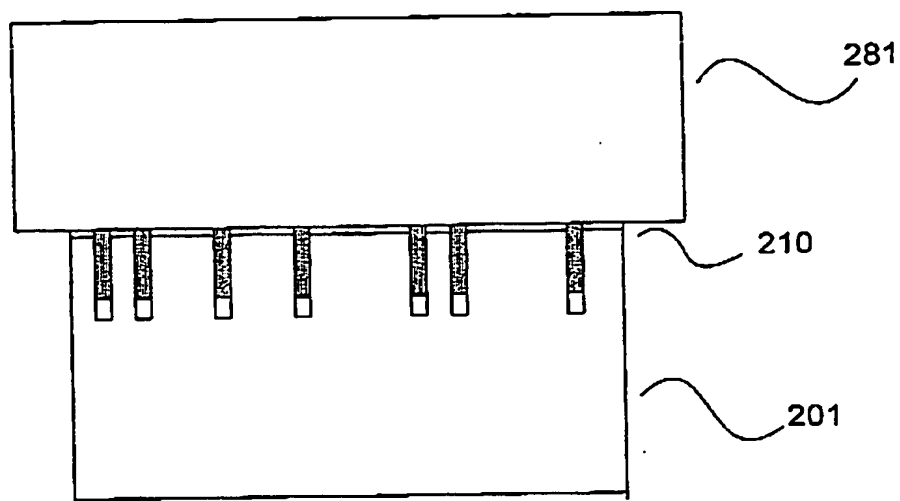
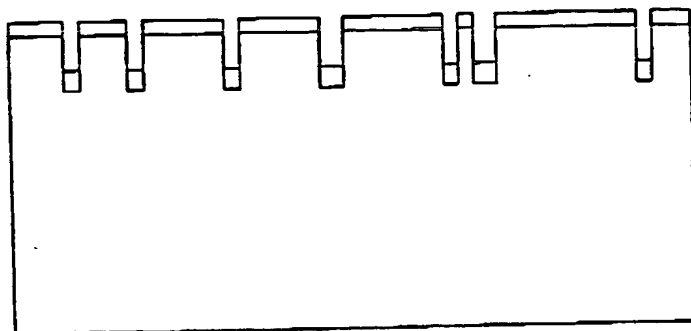


Fig. 2

**Fig. 3**



**Fig. 4**

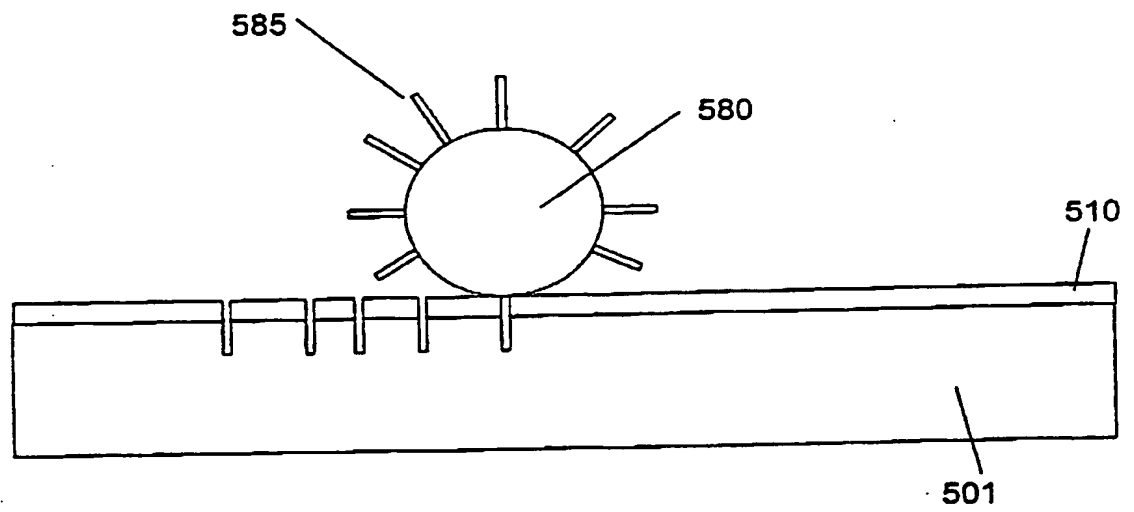


Fig. 5



# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SG 99/00074

## A. CLASSIFICATION OF SUBJECT MATTER

IPC<sup>7</sup>: H01L 21/027; 21/308; 21/311; 21/321

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC<sup>7</sup>: H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, PAJ, EPODOC

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category*   | Citation of document, with indication, where appropriate, of the relevant passages            | Relevant to claim No.   |
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| A           | WO 97/06012 A1 (IBMC) 20 February 1997 (20.02.97) abstract,<br>fig. 1,2,3.                    | 1, 54                   |
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☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

09 May 2000 (09.05.00)

Date of mailing of the international search report

20 June 2000 (20.06.00)

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SG 99/00074

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